2.4.4 Antenna Stabilization Limits

2.4.4.1. Purpose

The purpose of this test is to evaluate the ability of the radar antenna to maintain stabilization during maneuvering flight and to determine its effects upon ingress and weapon delivery tactics.

2.4.4.2. General

As discussed in the radar theory section, many radar antennas are gyroscopically or inertially stabilized in relation to the horizon within the boundaries of the scan and elevation limits; however, there are rate limitations to which the airplane can be maneuvered before this stabilization is degraded. The radar should be designed such that these boundaries are beyond the maneuvering limits of the host airplane for all three maneuvering axes (roll, pitch and yaw). Measuring yaw rates in flight without instrumentation is quite difficult, step inputs to the maximum allowable at a mission relatable maneuvering speed will be used instead of an actual yaw rate measurement. The loss of stabilization usually manifests itself as a degradation of mapping and detection, strobing and other perturbations of the general radar display. The minimum criteria is whether the display is still adequate for radar navigation and area orientation, as well as target detection and accurate target designation. Combined roll, pitch and yaw maneuvers can have their own effects upon the display and as such should also be evaluated.

2.4.4.3. Instrumentation

Data cards and a stop watch are required for the test with an optional voice recorder.

2.4.4.4. Data Required

Record the time to go from 40° nose low to 40° nose high at a constant g rate up to the g limit of the airplane. Record the time to roll 360° at increasing stick deflections. Record the percent of rudder throw used to achieve increasing yaw rates. During all maneuvers, make qualitative comments on the effects that the maneuvers have upon the radar display and detection performance. Record the same qualitative comments during rolling push-overs and pull-ups. Record qualitative comments concerning the effects of the antenna stabilization limits (if any are found) during mission relatable ingress evasive maneuvers and while performing mission relatable weapon deliveries.

2.4.4.6. Procedure

Climb to a medium altitude (approximately 15,000 feet AGL is typical) and set an airspeed that allows for safe, high g maneuvers (usually 300 to 400 KIAS is adequate). Establish a normal search or radar mapping mode. Select a scan angle limit at approximately 30° to 40° and set the antenna elevation to optimize the display around a point 30 to 40 nm ahead of the airplane. Center the display on the nose. Maneuver to 50° nose low and establish a 2g pull-up to 50° nose high at a constant 2g rate. Mark the time while passing from 40° nose low to 40° nose high. Note any degradation in the radar display, including any loss of detection at any ranges that were present before maneuvering, strobing or spoking on the display or any other effects. If the elevation angle limits are less than 50°, then a smaller maneuver will have to be performed to maintain contact with the target. Repeat the test at increasing g levels until degradation is noted or the g limit of the airplane is reached.

Center the scan volume 20° off of the nose. Roll the airplane 360° at 1/4 stick deflection, noting the time to complete the roll and any degradation in detection or the display. Repeat at 1/2, 3/4 and full stick deflection if the airplane limits allow. With the scan volume again centered on the nose, perform a step input of the rudder at 1/4 deflection. Note any degradation of detection or the display. Repeat at 1/2, 3/4 and full rudder deflections if the aircraft limits allow. If no degradation is noted while performing the tests above, perform a series of rolling push-overs and pull-ups at increasing g rates until the limits of the airplane are reached. Again, look for degradation in detection or the radar display. During ingress evasive maneuvers and weapon delivery maneuvers, note the effects upon tactics of the limits found above.

2.4.4.7. Data Analysis and Presentation

Divide the time to perform the pitch up maneuvers into the 80° covered to obtain the average pitch rate. Divide the time

to roll into 360° to get the average roll rate. If no degradation is noted within the maneuvering limits of the airplane during single axis or the multiple axis maneuvers, then the stabilization limits are probably satisfactory. If degradation is noted, it should be related to the limits that this degradation imposes upon tactics. The amount of limitation depends upon the axis involved (a pitch axis limit of 2g on an 8g airplane would be more serious than a yaw axis limit of 1/4 rudder deflection) and the level at which the degradation is noted. These limitations should be verified during mission relatable attacks.

2.4.4.8. Data Cards

Sample data cards are provided as card 27.

CARD NUMBER ___ TIME ___ PRIORITY L/M/H

AIR-TO-GROUND ANTENNA STABILIZATION LIMITS

[CLIMB TO _____ FEET AGL, SET ___KIAS AND SELECT A SEARCH OR MAPPING MODE AND A 30° TO 40° AZIMUTH LIMIT. OPTIMIZE THE ANTENNA ELEVATION FOR A 30 TO 40 NM RANGE MAP DISPLAY AND SELECT A RANGE SCALE TO COVER ALL THE RADAR VIDEO PROVIDED. PITCH DOWN TO 50° LOW AND PULL-UP AT 2G TO 50° NOSE HIGH. TIME 40° LOW TO 40° HIGH. NOTE ANY DEGRADATION. REPEAT AT INCREASING G RATES.]

TIME TO PITCH	G	DEGRADATION

[CENTER THE SCAN VOLUME 20° OFF OF THE NOSE. ROLL THE AIRCRAFT AT 1/4 STICK DEFLECTION. NOTE THE TIME TO ROLL 360° AND DEGRADATION. REPEAT AT 1/2, 3/4, AND FULL DEFLECTION.]

TIME TO ROLL	G	DEGRADATION

Card 27: Air-to-Ground Antenna Stabilization Limits Data Cards

AIR-TO-GROUND ANTENNA STABILIZATION LIMITS

[CENTER THE SCAN VOLUME ON THE NOSE. PROVIDE A STEP INPUT OF RUDDER AT 1/4 DEFLECTION. NOTE DEGRADATION AND REPEAT AT 1/2, 3/4 AND FULL DEFLECTION.]

RUDDER INPUT	DEGRADATION

[PERFORM EASY ROLLING PUSH-OVERS AND PULL-UPS, NOTING ANY DEGRADATION. REPEAT AT INCREASING G LEVELS UNTIL DEGRADATION IS NOTED OR THE AIRPLANE LIMITS ARE REACHED.]

DESCRIBE THE MANEUVER (CONTROL DEFLECTIONS, G LEVELS ETC.):

DEGRADATION:

[EVALUATE THE ANTENNA STABILIZATION LIMITS DURING MISSION RELATABLE EVASIVE MANEUVERS AND WEAPON DELIVERY MANEUVERS.]

TYPE OF MANEUVERS_____

DEGRADATION:

Card 27: Air-to-Ground Antenna Stabilization Limits Data Cards (Continued)